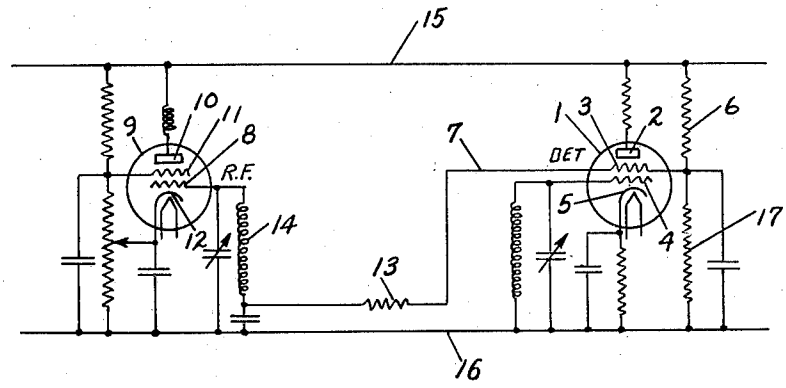
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MEANS FOR OBTAINING AUTOMATIC VOLUME CONTROL IN RADIO SETS

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MEANS FOR OBTAINING AUTOMATIC VOLUME CONTROL IN RADIO SETS

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My invention is addressed to means which are automatic in their action for controlling the volume in radio sets to the extent of preventing the overload of parts and a consequent diminution or distortion in output. It is well understood that if the output of a radio tube is plotted against the input, the output will rise with input to a certain maximum beyond which further increases in the input current strength will not produce corresponding increases in output. In some instances the output actually decreases with a further input increase; and distortion is introduced into the output at a point beyond, but very close to, the effective maximum output point on the curve.

The object of automatic volume control in radio sets is primarily to prevent the input current from rising beyond the point represented by the maximum value (without distortion) of the output for any given element, or for the set in general. This is ordinarily accomplished by some automatically actuated means which will cut down the sensitivity of preceding tubes in the set so that the value of the input current respecting some other tube or tubes, is prevented from rising beyond an allowable maximum. An element of the radio set may be caused to act as a control element and to supply a current which will affect the grid bias of preceding tubes to this end; and it is advantageous, of course, to select as the controlling element, that element which is most likely to become overloaded. For this reason it is advantageous in a system of this character to make the detector tube the controlling element and preceding radio frequency tubes the controlled elements, in sets having radio frequency detector and amplifier stages. My invention is not limited in this way, however, and any tube in a set may, if desired, be caused to control the amplification characteristics of a preceding tube or tubes.

An increase in the grid bias of a preceding tube should, of course, cut down the amplifying characteristic of that tube. In order that the sensitivity of the set may not be impaired upon weak signals, or signals which do not reach the allowable maximum, it is clearly preferable to have volume control means which cut in sharply, at or around the desired point of allowable input maximum, but increase very rapidly in their action as the current rises beyond this point so that the input to succeeding tubes or stages may be held substantially constant at the highest permissible value.

An object of my invention is the production of volume control means of the type generally referred to hereinabove which are simple and effective in construction.

Another object of my invention is the production of automatic volume control which is more readily controlled, together with means to this end.

Still another object of my invention is the provision of means for volume control in which it is certain that the incoming signal will be cut down in strength prior to the point where distortion enters into the output current.

These and other objects of my invention which will be set forth hereinafter, or will be apparent to one skilled in the art upon reading these specifications, I accomplish by that certain construction and arrangement of parts of which I shall now describe a preferred embodiment, reference being had to the accompanying drawing, wherein I have shown in a diagrammatic manner, a circuit illustrating the essential features of my invention. The drawing is diagrammatic and the parts of a radio circuit not having to do directly with my volume control means, have not been shown, since these parts are well known in the art, and since they may vary from set to set, inasmuch as my volume control means may be applied to sets of different character as will hereinafter appear.

I have discovered, as set forth in my copending application, Serial No. 455,353, filed May 24, 1930, that at or about the point of overload in a tube, such as the detector tube of a radio set, the grid thereof begins to draw current and that it is possible to impress this current back upon the grids of preceding tubes to vary the bias thereof. In one aspect my present invention is an improvement upon the invention set forth in the said application for Letters Patent, since I effect volume control by a current drawn in a controlling element from a point between the plate and the filament or electron emitting device thereof. As respects the invention of my said application, and its practical application, I have found a very close correspondence between the overload point in tubes and the point at which the grid begins to draw current, so much so that entire success has attended the control of volume by this means. But the overload point, the point of maximum volume without distortion, and the point at which the grid begins to draw current, vary somewhat in their relationship from tube to tube, and it is conceivable that in some tubes now or hereafter in use, the overload and distortion points may be reached prior to the time when volume control of

the type of my co-pending application, becomes entirely effective.

My present invention applies to screen grid or tetrode tubes, and it contemplates a way of insuring that the grid bias of preceding tubes is increased to effect volume control prior to the overload point. The screen grid of a tetrode tube also draws current after the input value of the said tube has reached a certain maximum, but as will be readily understood from a consideration of the nature of tetrode tubes, the screen grid will begin to draw current in advance of a condition in the tube which would cause the grid itself to draw current. Current is drawn, therefore, in the screen grid definitely prior to the overload point of the tube and definitely prior to the introduction of distortion into the tube output. I am thus able to effect volume control just as sharply as before, but earlier. Due to the fixed characteristics of the tube, the point at which the screen grid draws current will always be in advance of the point of overload and distortion, and in advance of the point at which the grid itself would draw current. The exercise of volume control from the screen grid potential does not, however, cut down the maximum volume of the set by any appreciable amount.

In the drawing, I have shown a controlling tube 1, which may be thought of as a detector tube, although it may be another tube in the set. This tube has a plate 2, a screen grid 3, a grid 4, and an electron emitting device, or cathode 5. In this tube the screen grid current will increase with the radio frequency voltage applied to the control grid. This current increases rapidly near and before the overload point of the detector, and this increase is what I have referred to herein as "drawing current." I have shown in the figure a high resistance element 6, in series with the screen grid 3, and between it and a connection to the plate circuit of the tube. I have also shown a lead 7 connecting the screen grid 3 with the grid 8 of a preceding tube or tubes 9. The tube 9 may be a radio frequency tube also of the tetrode type. Its plate is shown at 10, and its screen grid at 11. 12 indicates its cathode. The screen grid of tube 1 may be connected to the grid of tube 2 through an isolating resistance 13, in order to prevent coupling, and also through such other instrumentalities as the input secondary 14 of the tube 9. The plate circuit of the several tubes is diagrammatically shown as connected to a lead 15 of positive potential, and the cathodes diagrammatically shown as connected to a lead 16. A stabilizing resistance 17 may be connected between the screen grid and the cathode circuit of the tube 1. Its function is to help stabilize the screen grid. The voltage of the radio frequency cathodes, such as 12, may be adjusted so that with weak signals on the detector tube 1, the bias on the radio frequency tubes, such as the tube 9, is correct for maximum sensitivity. An increase in the input signal value to the detector will increase the current in the resistance 6, thus decreasing the screen grid voltage, which in turn, increases the bias on the radio frequency tube or tubes 9, thereby decreasing their amplification until a point of balance is reached.

In a typical circuit according to my invention, the element 13 has a resistance of one megohm, and the elements 6 and 17 have resistances of 500,000 ohms each. The lead 16 is at ground or —B potential and the lead 15 has a potential of 300 volts, or the B+ supply. In the detector tube 1, the screen grid 3 is at a potential of about 50 volts above ground, while the cathode 5 is at a potential of about 6 volts above ground. In the tube 9, the screen grid is at a potential of about 150 volts above ground, and the cathode of this tube is at about 53 volts above ground, being adjusted to give a net bias of about 3 volts on the grid 8.

It will be understood that modifications may be made in my invention without departing from the spirit thereof.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent, is:—

1. In a radio set having at least one tetrode tube and at least one preceding tube, an ungrounded connection between the screen grid of said tetrode tube and the grid of the preceding tube in said set.

2. In a radio set having at least one tetrode tube and at least one preceding tube, an ungrounded connection between the screen grid of said tetrode tube and the grid of the preceding tube in said set, and a resistance in series with said screen grid and a plate circuit of said tetrode tube.

3. In a radio set having a B source, at least one tetrode tube and at least one preceding tube, a connection between the screen grid of said tetrode tube and the grid of the preceding tube in said set, a resistance in series with said screen grid, and a plate circuit of said tetrode tube, and a stabilizing resistance between said screen grid and the negative side of the B source.

4. The method of obtaining automatic volume control in a radio set comprising a tetrode tube and a preceding tube which consists in impressing back the screen grid variations of potential in the tetrode tube upon the grid of the preceding tube, thereby modifying the grid bias of said preceding tube in accordance with the screen grid potential of the tetrode tube to control the amplification of the preceding tube in accordance with the value of the screen grid potential of the tetrode tube.

LOUIS F. WILLGING.